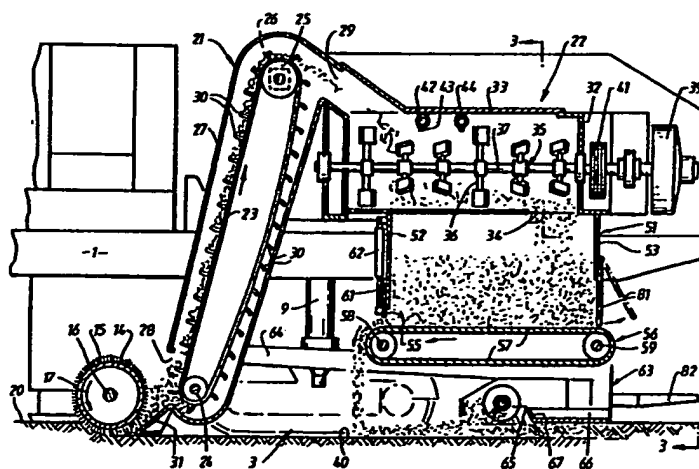




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>4</sup> :</b>  <b>E01C 23/12, 19/46, 19/05</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 90/10752</b>  <b>(43) International Publication Date:</b> 20 September 1990 (20.09.90)
<b>(21) International Application Number:</b> PCT/AU90/00109 <b>(22) International Filing Date:</b> 16 March 1990 (16.03.90)  <b>(30) Priority data:</b> PJ 3256 16 March 1989 (16.03.89) AU  <b>(71) Applicant (for all designated States except US):</b> BP AUSTRALIA LIMITED [AU/AU]; 1 Albert Road, Melbourne, VIC 3000 (AU).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only) :</b> HALL, Kenneth, Douglas [AU/AU]; 5 Fowler Road, Dandenong, VIC 3175 (AU).  <b>(74) Agent:</b> GRIFFITH HACK & CO.; 2nd Floor, 601 St. Kilda Road, Melbourne, VIC 3004 (AU).		<b>(81) Designated States:</b> AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.  Published With international search report.

**(54) Title:** ROAD SURFACE RECYCLER**(57) Abstract**

A road surface recycler for cutting road pavement material from a road, pulverizing that material, mixing it with a liquid binder and relaying it onto the road surface. A single mobile structure carries a reclaimer drum (14) for cutting paving material from the road, a pulverizer (22) for breaking up the material and mixing it with a binder and a delivery means (56) for relaying the material onto the road. The reclaiming drum (14) is driven in a direction (17) to cut downwardly into the road surface (40) and pass the cut material rearwardly under the drum for delivery to the pulverizer. The pulverized material is delivered to a surge bin (51) which can accumulate material until it can be deposited on the road at a position already traversed by the reclaimer drum.

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ROAD SURFACE RECYCLERTECHNICAL FIELD

This invention relates to road surface recycling.

In the past in the United States it has been known to provide a road surface recycling system which comprises a mobile surface reclaimer which removes paving material from the surface of a road by means of a rotating drum which has cutting bits around the periphery. The drum rotates so as to cut in an upward direction into the road surface which produces large pieces of paving material. These are fed onto a conveyor which extends out behind the surface reclaimer to a further mobile machine travelling behind the reclaimer. The further machine includes a screening system arranged to pass relatively small pieces to a mixing means where the smaller pieces and binding material are mixed. Larger pieces are passed from the screening means to a crusher towed by the mobile machine, the output of the crusher being fed back through the screening means to the mixer. Behind the screening, crushing and mixing machine there is further mobile machine which receives the output of the mixer via a further conveyor, the mixer output being fed to a hopper from which material is metered to a paver machine for repaving the road surface.

This system is very costly and also the "train" of mobile machinery is too long to be turned around so as to travel in the opposite direction without disconnecting the machines from one another and individually turning the machines around followed by again coupling them together in their working relationship. The present invention provides a road surface recycler by which reclaiming, pulverizing and relaying of material can be carried out by a single mobile machine which is relatively compact and easy to operate.

DISCLOSURE OF THE INVENTION

According to the invention there is provided a road surface recycler comprising:

a mobile structure mounted on ground engaging means adapted to support the mobile structure for movement across the ground whereby the structure can be advanced along a paved road;

a paving material reclaimer mounted on the mobile structure and operative when the mobile structure is advanced along a paved road to cut road paving material from the surface of the road;

a pulverizer mounted on the mobile structure to receive road paving material cut from the road by the reclaimer; and

delivery means to deliver pulverized material from the pulverizer onto the road surface from which paving material has been removed by the reclaimer.

Preferably the road surface reclaimer comprises a rotary drum fitted with cutting elements around its circumference and mounted on the mobile structure for rotation about a generally horizontal axis transverse to the direction of travel of the recycler and reclaimer drive means operative to drive the drum in such a direction as to cut downwardly into the surface of the road so that paving material cut from the road surface is passed rearwardly of the direction of travel beneath the drum.

Preferably further, the mobile structure also carries a bin to receive pulverized material from the pulverizer and the delivery means comprises a conveyor operable to transport pulverized material from the bin and to deliver it onto the road surface.

The mobile structure may carry a screed to spread pulverized material delivered by the conveyor onto the road surface and the conveyor may be operable normally to deliver pulverized material from the bin to the road surface ahead of the screed but may be alternatively operable to discharge pulverized material from the bin from the rear of the recycler.

#### BRIEF DESCRIPTION OF DRAWINGS

In order that the invention may be more fully explained, one particular embodiment will be described with reference to the accompanying drawings in which

Figure 1 is a side elevation of a road surface recycler constructed in accordance with the invention;

Figure 2 is a vertical cross-section through the main parts of the road recycler illustrated in Figure 1; and

Figure 3 is a cross-section taken generally on the line 3-3 in Figure 2.

BEST MODE OF CARRYING OUT THE INVENTION

The illustrated road surface recycler comprises a mobile main machine structure denoted generally as 1, mounted on grounding engaging means in the form of front and rear crawler assemblies 2 and 3 spaced longitudinally of the direction of travel of the recycler. The two front crawler assemblies 2 are disposed one to each side of the machine and each comprises a steering bogie 4 carrying idler sprockets 5 and a crawler track 6. Each bogie 4 is mounted on a post 7 which extends up into a housing at the front end of the main machine structure 1. The rear pair of crawler assemblies 3 are also disposed one to each side of the machine. Each rear assembly comprises a driving bogie 8 mounted on a post 9 and fitted with sprockets 10 and crawler track 11. Each of the driving bogies 8 carries a hydraulic motor coupled to one of the sprockets to drive the crawler track 11 whereby the machine can be propelled along a road in either direction. The mounting posts 9 for the rear crawler assemblies extend up into the main machine frame structure 1. Both the forward posts 7 and rearward posts 9 may incorporate hydraulic rams operable to raise and lower the main machine structure on the crawler assemblies so as to allow the machine to be raised from its normal operating condition for transport and manouvering onto a low loader.

The hydraulic controls for the drive motors, the steering gear and various other components of the machine yet to be described are grouped together in a control console 12 at an operator's station 13 located near the forward end of the machine.

Between the forward crawler assemblies 2 and the rearward crawler assemblies 3, the main machine frame carries a road paving reclaimer drum 14 fitted with cutting elements 15 around its circumference and mounted on structure 1 by a shaft 16 for rotation about a horizontal axis extending transverse to the direction of travel of the machine. The reclaimer drum is driven from a power take-off via a gear box, clutch and pulley and belt drive in the direction indicated by the

arrows 17 so that as the reclaimer advances forwardly along a paved road surface 20, the reclaimer drum cuts downwardly into the road surface to cut paving material from the road surface and to pass the cut material rearwardly of the direction of travel beneath the drum. The downward cutting action ensures that large pieces of paving are not lifted from the road surface but pieces are cut progressively to a generally small size determined by the spacing of the cutters around the drum. The drum and cutters also act to pulverize the cut material to some extent as it passes under the drum.

Paving material cut from the paved road surface and passing rearwardly beneath the drum is collected by a bucket elevator denoted generally as 21 which lifts the material rearwardly and upwardly to discharge it into a pulverizer denoted generally as 22 which is mounted on the main machine frame structure 1 behind and above the reclaimer drum 14. Bucket elevator 21 comprises a series of buckets 30 fixed to drive chains 23 extending around lower idler sprockets 24 and drive sprockets 25 driven from a hydraulic motor 26. The bucket assembly is disposed within an elevator housing 27 having a bottom inlet opening 28 and an upper discharge opening 29. The lower end of housing 27 is formed with a downwardly and forwardly projecting scoop extension 31 to scoop up the cut material and direct it into the elevator opening 28 whence it is lifted by the buckets 30 to the top of the elevator housing and discharges through the opening 29 into the pulverizer 22.

Pulverizer 22 may be constructed as a conventional pug mill. It comprises a sturdy steel pulverizing vessel 32 with top hatches 33 and a bottom discharge opening 34 at the rear end of the vessel 32. The pulverizing vessel defines a rectangular pulverizing chamber in which are mounted two contra-rotating paddle assemblies 35. The paddle assemblies comprise paddle arms 36 radiating out from two parallel paddle shafts 37 extending through the pulverizing chamber in the front to rear direction. In the mid part of the pulverizing chamber the paddle arms of one assembly project between the arms of the other assembly and the two sets of paddle arms are contra-rotated as indicated by the arrows 38 by the operation

of a hydraulic motor 39 mounted at the rear of the pulverizer vessel and driving the shafts 37 through a belt drive 41. The action of the paddles on the reclaimed road material delivered into the pulverizing chamber is to mix the material and to move it progressively to the rear of the pulverizing chamber toward the bottom discharge outlet 34.

The reclaimed paving material in the pulverizer 22 is mixed with a liquid binder in the form of a water and bitumen emulsion sprayed into the pulverizer chamber through a pipe manifold 42 extending through the upper part of the chamber rearwardly from the inlet and provided with sprays 43. The emulsion is supplied to the pipe manifold from a tank 45 mounted on the machine frame structure 1 or from a separate tanker driven in front of or beside the reclaimer. An auxiliary water supply manifold 44 also extends through the upper part of the pulverizer chamber. Additional water can be sprayed into the pulverizer chamber through this auxiliary manifold when necessary to increase the moisture content of the mixture leaving the pulverizer.

The pulverized mixture of reclaimed road material and emulsion drops through the pulverizer outlet 34 into a surge bin 51 which is mounted on the main machine structure 1 immediately below the pulverizer. Bin 51 has upright front and rear walls 52, 53 and side walls 54 which slope laterally inwardly of the machine to a bottom outlet 55. A belt conveyor 56 extends across the bottom outlet 55 of the bin in the front to rear direction of the machine. Conveyor 56 comprises a conveyor belt 57 mounted on front and rear rollers 58, 59 and the front rollers are driveable by an internal hydraulic motor 60 to drive the conveyor belt in forward and reverse directions. When the conveyor belt is driven in the forward direction it transports material from the bottom of the surge bin 51 forwardly of the machine and drops it onto the road surface 40 from which paving material has been removed by the reclaimer 14. The front wall 52 of bin 51 carries a vertical slide plate 61 which can be raised and lowered by operation of a hydraulic ram 62 to vary the rate of feed of material from the bin when the conveyor is operated to discharge material

forwardly from the bin.

When conveyor 57 is operated to convey material forwardly from the bin it discharges the material onto the road surface 40 in advance of a screed assembly 63 disposed beneath the conveyor 57 and mounted on the machine structure 1 via a pair of pivot arms 64. The screed assembly comprises a pair of spiral augers 65 extending transversely of the machine and a screed plate 66 with an upturned leading edge 67 extending across the machine immediately behind the augers 65. The augers are driven independently of one another through internal hydraulic motors so as to spread the material deposited into a windrow by conveyor 57 across the road surface before it is finally consolidated and smoothed by the action of the screed plate 66. The screed assembly simply hangs under its own weight on pivot arms 64 to level the deposited material. The angle of attack of the screed can be varied by raising and lowering the forward ends of the pivot arms 64 by the operation of a pair of hydraulic rams 71. The lower ends of rams 71 are pivotally attached to lugs 72 adjacent the front ends of pivot arms 64 which are provided with pins 73 engaging vertical slide bars 74 fixed to the main machine structure 1. The front ends of pivot bar 74 are thus held at a height dependant on the setting of rams 71 and are free to pivot about the pivot connections 72 but the substantial drag forces applied to the arms 64 are transmitted to the machine frame via the pins 73 and bars 74. Two additional hydraulic rams 75 are connected between the machine frame and the screed assembly so as to be operative to lift the screed assembly well away from the road surface for transport.

The rear wall 53 of surge bin 51 is provided with a rearwardly opening gate 81 to allow rapid discharge of material from the rear of the bin by reverse operation of conveyor 57. Material may thus be dumped directly in a pile or windrow behind the machine or may be discharged into an elevator brought up to the rear of the machine to transfer the material into another vehicle for transport to another location.



A pair of wing platforms 82 project from the rear of the screed assembly. An operator may stand on one of these platforms to maintain inspection of the finished surface of the recycled material. Remote controls may be provided at this location for control of the conveyor 57, feed rate adjustment rams 62 and the screed adjustment rams 71.

Surge bin 51 has sufficient capacity to carry an amount of paving material which is cut from a length of a paved road surface equal to the distance between the reclaimer drum 14 and the screed assembly 63. This enables material to be carried forward at the commencement of a reclaiming run until it can be deposited on that part of the road from which material has been removed. In conventional machinery without the provision of such a surge bin, the removed material must be deposited continuously and at the commencement of a run the material is therefore dumped onto an unreclaimed part of the road and must be subsequently collected. The bin capacity should be sufficient to accomodate material cut from a road with a paving thickness up to about 150 mm. A typical machine may have a cutting width of two metres and an effective distance between the reclaimer and the screed of about 3.3 metres. For a pavement thickness of 150 mm the minimum capacity requirement would be about 2.22 tonnes in which case the bin may typically have a capacity of about 3 tonnes.

CLAIMS

1. A road surface recycler comprising:
  - a mobile structure mounted on ground engaging means adapted to support the mobile structure for movement across the ground whereby the structure can be advanced along a paved road;
  - a paving material reclaimer mounted on the mobile structure and operative when the mobile structure is advanced along a paved road to cut road paving material from the surface of the road;
  - a pulverizer mounted on the mobile structure to receive road paving material cut from the road by the reclaimer; and
  - delivery means to deliver pulverized material from the pulverizer onto the road surface from which paving material has been removed by the reclaimer.
2. A road surface recycler as claimed in claim 1, wherein the road surface reclaimer comprises a rotary drum fitted with cutting elements around its circumference and mounted on the mobile structure for rotation about a generally horizontal axis transverse to the direction of travel of the recycler and reclaimer drive means operative to drive the drum in such a direction as to cut downwardly into the surface of the road so that paving material cut from the road surface is passed rearwardly of the direction of travel beneath the drum.
3. A road surface recycler as claimed in claim 2, wherein the pulverizer has an inlet for material to be pulverized disposed rearwardly and upwardly from the cutting drum of the reclaimer and there is mounted on the mobile structure an elevator to receive reclaimed paving material passed rearwardly under the reclaimer drum and to transport that material to the pulverizer inlet.
4. A road surface recycler as claimed in any one of the preceding claims, wherein the mobile structure also carries a binder applicator for applying a liquid binder to the reclaimed material within the pulverizer so that the binder will be mixed with that material as it is pulverized.

5. A road surface recycler as claimed in any one of the preceding claims, wherein the mobile structure also carries a bin to receive pulverized material from the pulverizer and the delivery means comprises a conveyor operable to transport pulverized material from the bin and to deliver it onto the road surface.

6. A road surface recycler as claimed in claim 5, wherein the conveyor has drive means operable to drive the conveyor at variable speeds.

7. A road surface recycler as claimed in claim 5 or claim 6, wherein the mobile structure carries a screed to spread pulverized material delivered by the conveyor onto the road surface.

8. A road surface recycler as claimed in claim 7, wherein the bin is of sufficient volume to carry an amount of reclaimed and pulverized material reclaimed from a paved road surface of mm paving thickness over a length of road equal to the distance between the reclaimer and the screed.

9. A road surface recycler as claimed in claim 7 or claim 8, wherein the conveyor is operable normally to deliver pulverized material from the bin to the road surface ahead of the screed but is alternatively operable to discharge pulverized material from the bin from the rear of the recycler.

10. A road surface recycler as claimed in any one of claims 5 to 9, wherein the conveyor is a belt conveyor extending across an opening in the bottom of the bin in the fore and aft directions with respect to the direction of travel and is normally operable to feed pulverized material from the bottom of the bin forwardly and to discharge that material from the forward end of the conveyor onto the road surface but is alternatively operable in a reverse direction to discharge pulverized material from the rear of the conveyor.

11. A road surface recycler as claimed in claim 10, wherein the bin is provided at the front of said bottom opening with a raisable and lowerable slide to adjust the rate of forward feed of the pulverized material on the conveyor.

12. A road surface recycler as claimed in claim 10 or claim 11, wherein the rear of the bin has a door which is openable to increase the rate of rearward discharge of pulverized material in reverse operation of the conveyor.

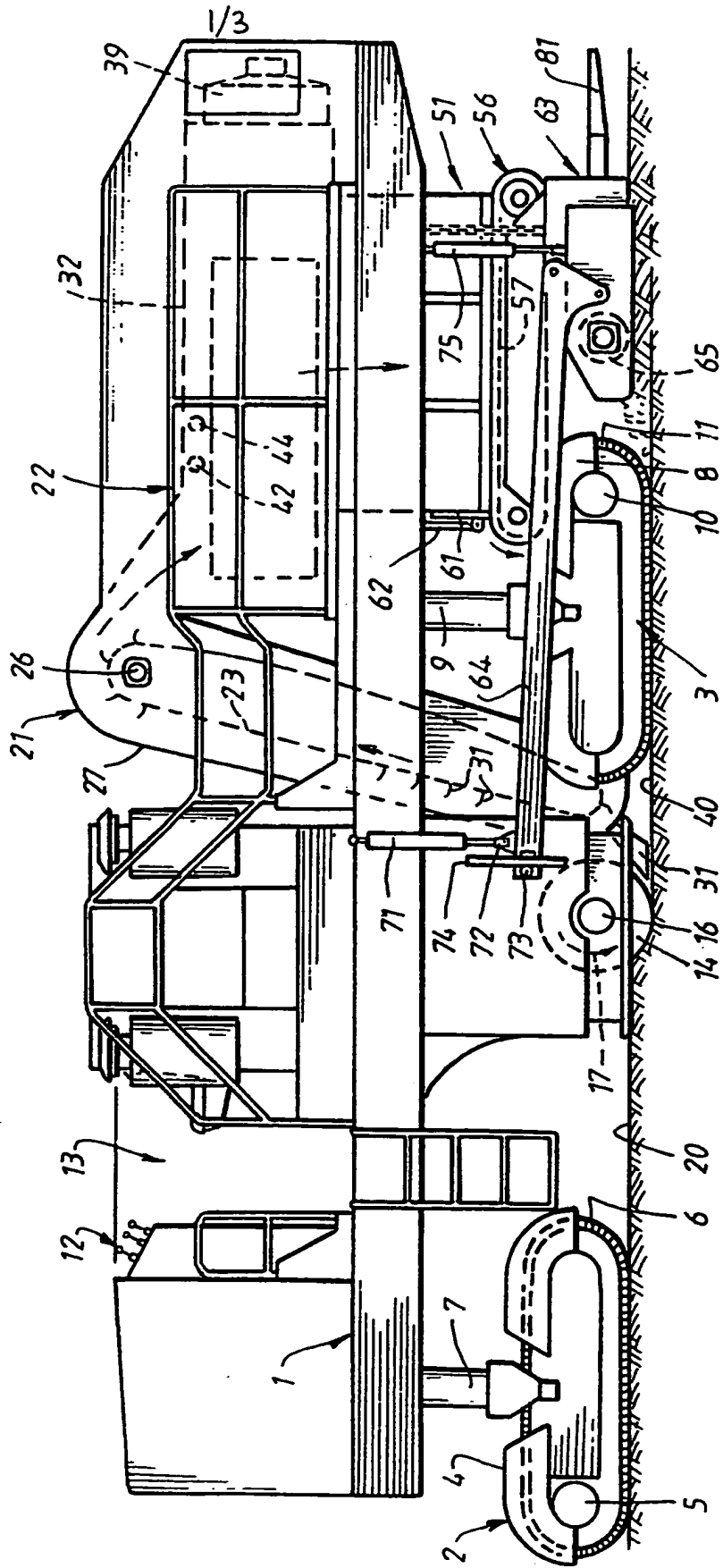
13. A road surface recycler as claimed in claim 1, wherein the road surface reclaimer comprises a rotary drum fitted with cutting elements around its circumference and mounted on the mobile structure for rotation about a generally horizontal axis transverse to the direction of travel of the recycler and reclaimer drive means operative to drive the drum in such a direction as to cut downwardly into the surface of the road so that paving material cut from the road surface is passed rearwardly of the direction of travel beneath the drum;

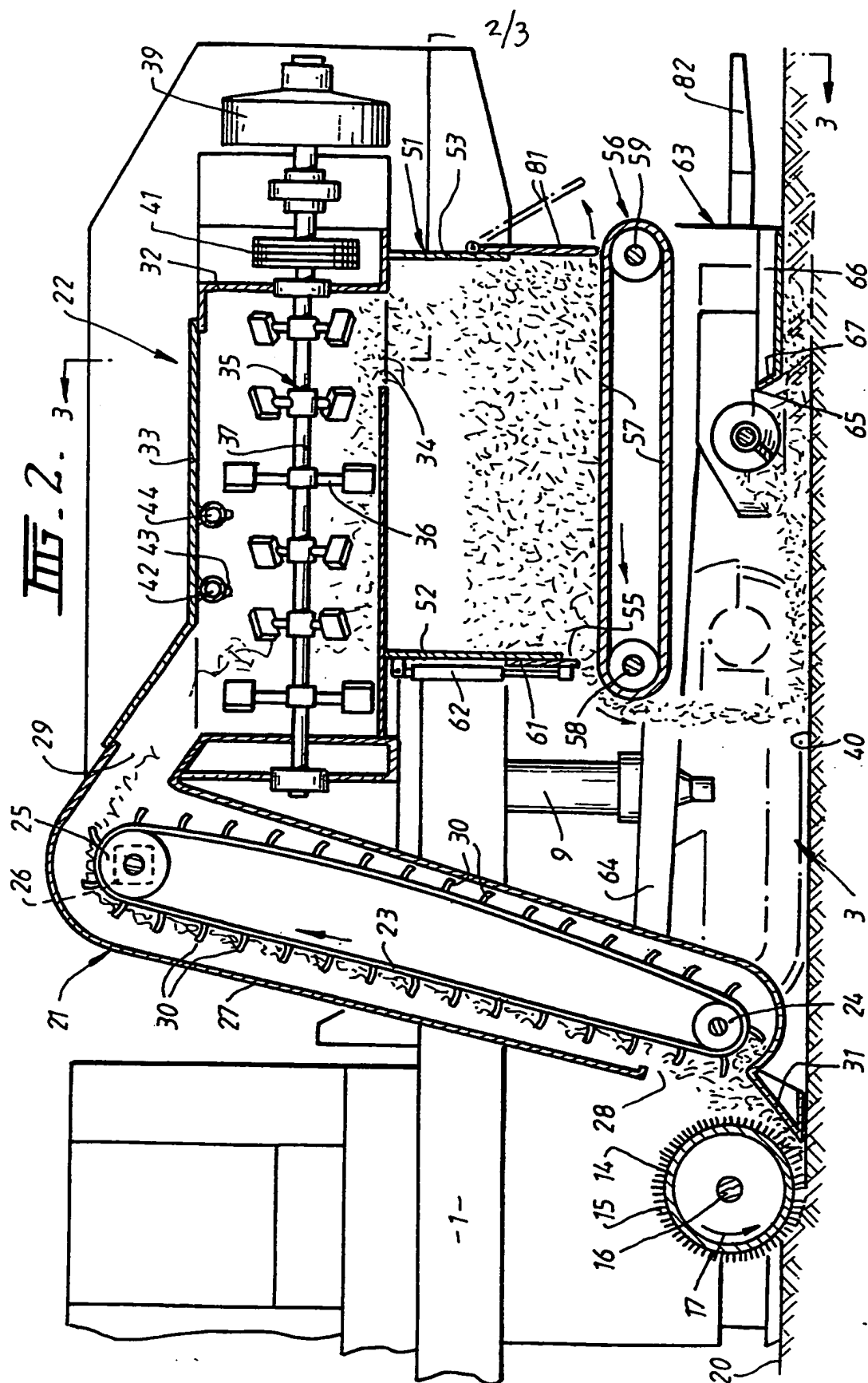
the pulverizer has an inlet for material to be pulverized disposed rearwardly and upwardly from the cutting drum of the reclaimer and there is mounted on the mobile structure an elevator to receive reclaimed paving material passed rearwardly under the reclaimer drum and to transport that material to the pulverizer inlet;

the pulverizer is disposed above a bin mounted on the mobile structure to receive pulverized material from the pulverizer; the mobile structure carries a screed disposed generally beneath the pulverizer and the bin; and

the delivery means comprises a belt conveyor extending across an opening in the bottom of the bin in the fore and after directions with respect to the direction of travel between the bin and the screed and is normally operable to feed pulverized material from the bottom of the bin forwardly and to discharge that material from the forward end of the conveyor onto the road surface ahead of the screed but is alternatively operable in a reverse direction to discharge pulverized material from the rear end of the conveyor behind the screed.

III. 1.





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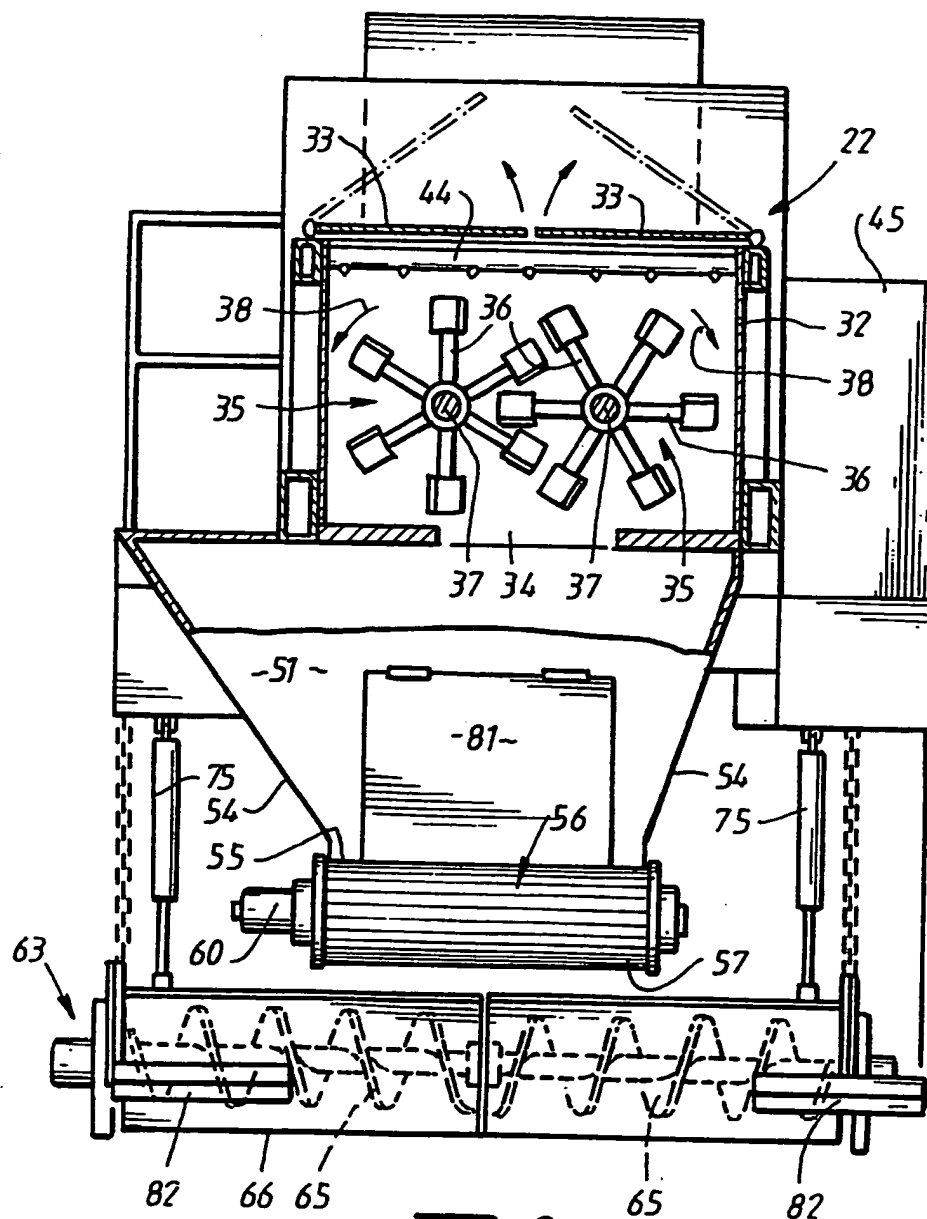
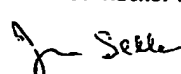


FIG. 3.

# INTERNATIONAL SEARCH REPORT

International Application No. **PCT/AU 90/00109**

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) 6		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. <sup>4</sup> <b>E01C 23/12, 19/46, 19/05</b>		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched 7		
Classification System	Classification Symbols	
IPC	<b>E01C 23/12, 19/46, 19/05</b>	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8		
AU : IPC as above		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> 9		
Category*	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
X	US,A, 2905456 (RAFFERTY et al) 22 September 1959 (22.09.59)	1, 2
X	WO,A, 85/03974 (CATERPILLAR TRACTOR CO) 12 September 1985 (12.09.85)	1-5
X,Y	EP,A, 0162792 (SOCIETE DE MATERIEL DE MANUTENTION ET DE CONCASSAGE et al) 9 May 1985 (09.05.85)	1-8
X,Y	US,A, 3843274 (GUTMAN et al) 22 October 1974 (22.10.74)	1-8
X,Y	US,A, 4011023 (CUTLER) 8 March 1977 (08.03.77)	1-8, 10
X,Y,E	EP,A, 0316752 (EGLI AG) 24 May 1989 (24.05.89)	1-8
(continued)		
<p>* Special categories of cited documents: 10</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Z" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <b>1 June 1990 (01.06.90)</b>		Date of Mailing of this International Search Report <b>25 JUN 1990</b>
International Searching Authority <b>Australian Patent Office</b>		Signature of Authorized Officer   <b>J.M. SELLARS</b>



## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

Y	EP,A, 0132202 (ERMONT S.A.) 23 January 1985 (23.01.85)	1-8
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V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE 1

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claim numbers ..., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4 (a):

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING 2

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

## Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

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